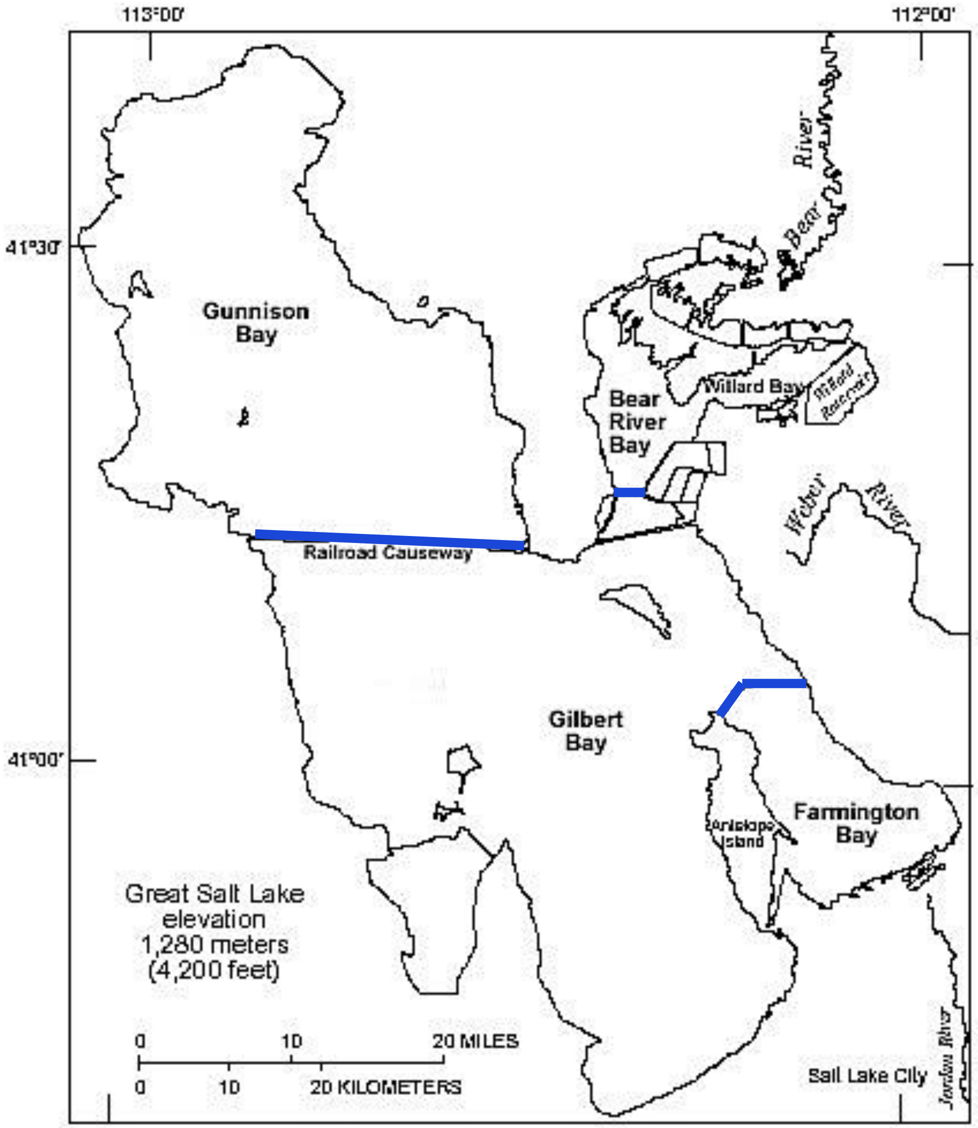
The effects of salinity on plankton & benthic communities in the Great Salt Lake*

Wayne Wurtsbaugh & Brian Barnes
Utah State University

*Barnes, B.D. and W.A. Wurtsbaugh. 2015. The effects of salinity on plankton and benthic communities in the Great Salt Lake, Utah, USA: a microcosm experiment. Can. J. Fish. Aquatic Sci. 72(6): 807-817.

GSL Tech Team Meeting
17 December 2015

Causeways & River Inflows from the Wasatch Mountains create large salinity differences in the different bays

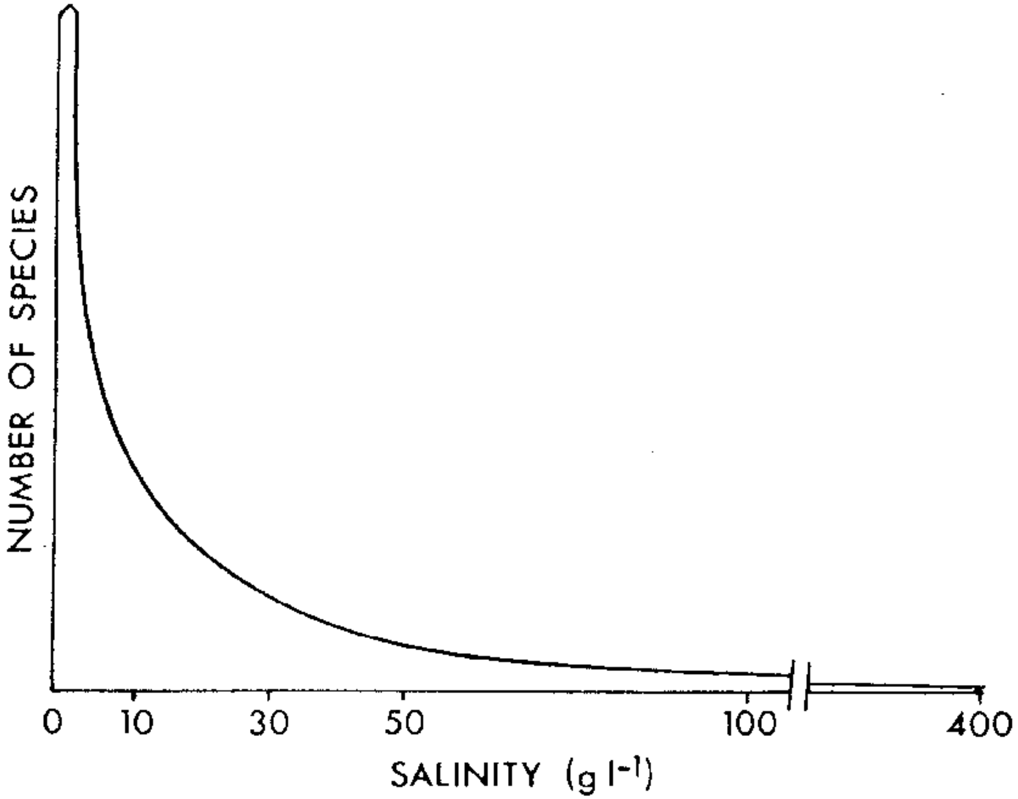


Farmington & Bear River Bays Salinities <1 - 9%

Gilbert Bay Salinities 6 - 18% (presently 17%)

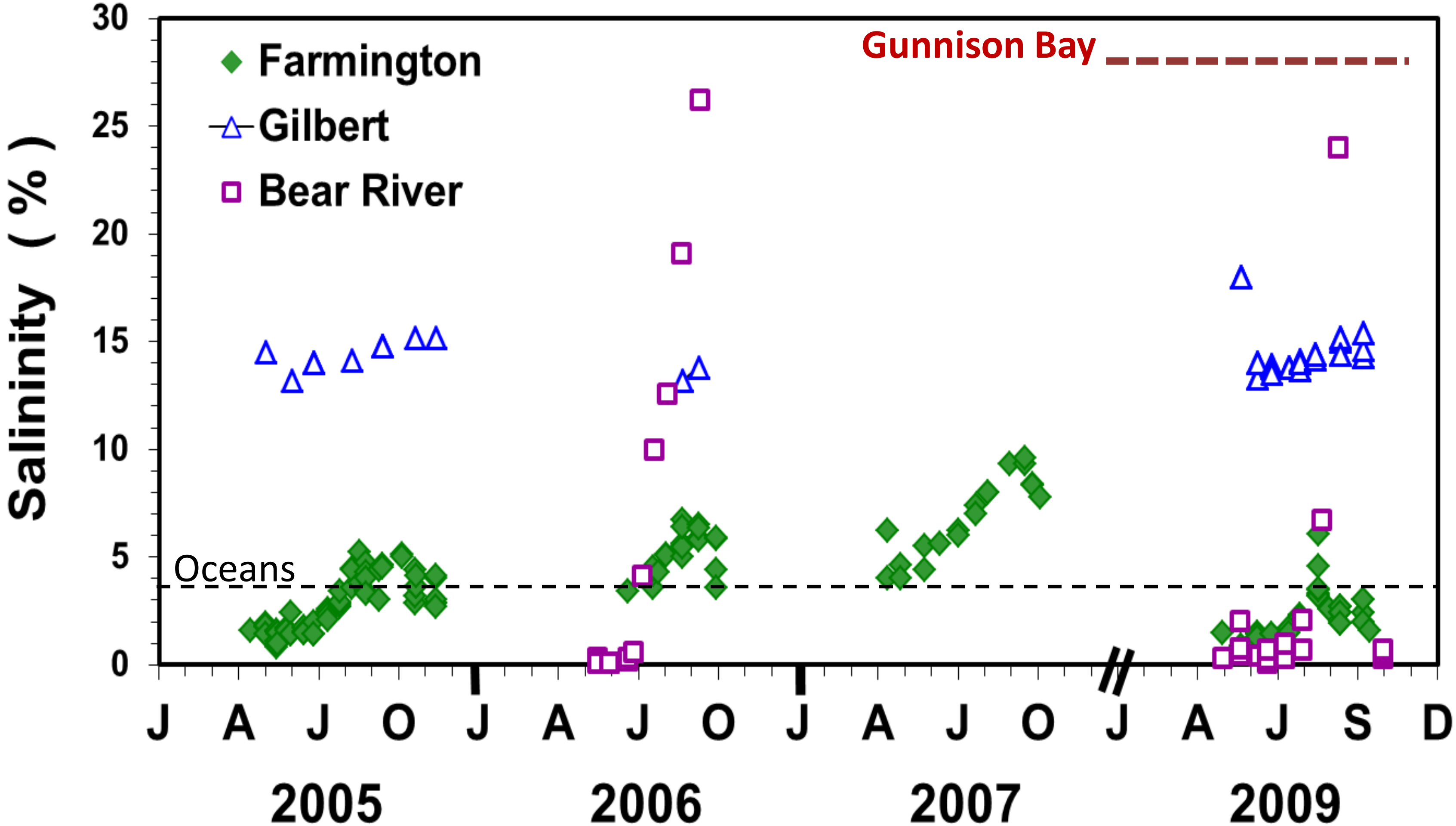
Gunnison Bay 16-29%

Salinity decreases the number of species that are tolerant and populate saline lakes

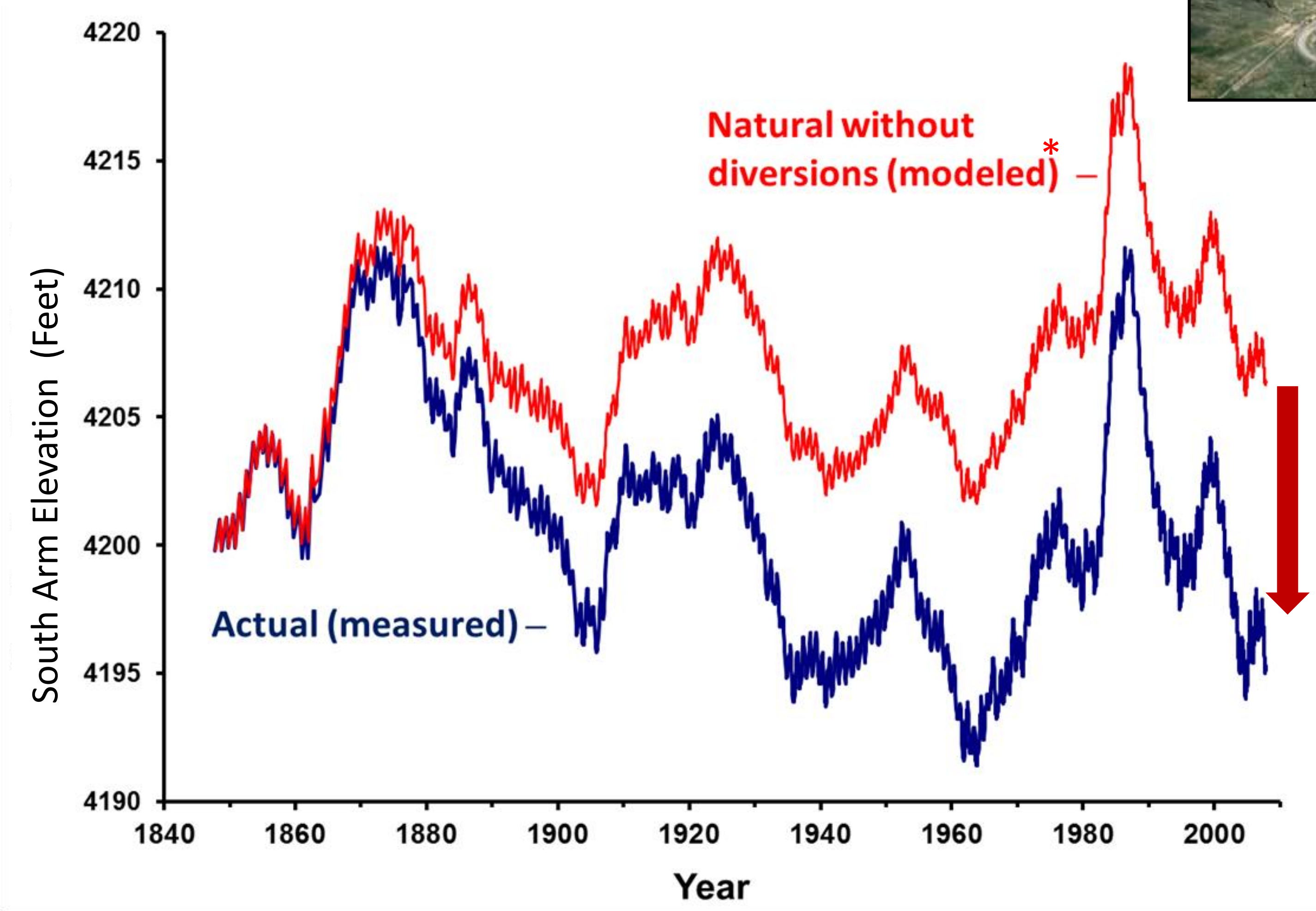


Williams, J.D. 1998. Hydrobiologia.

Annual changes in salinities in three bays



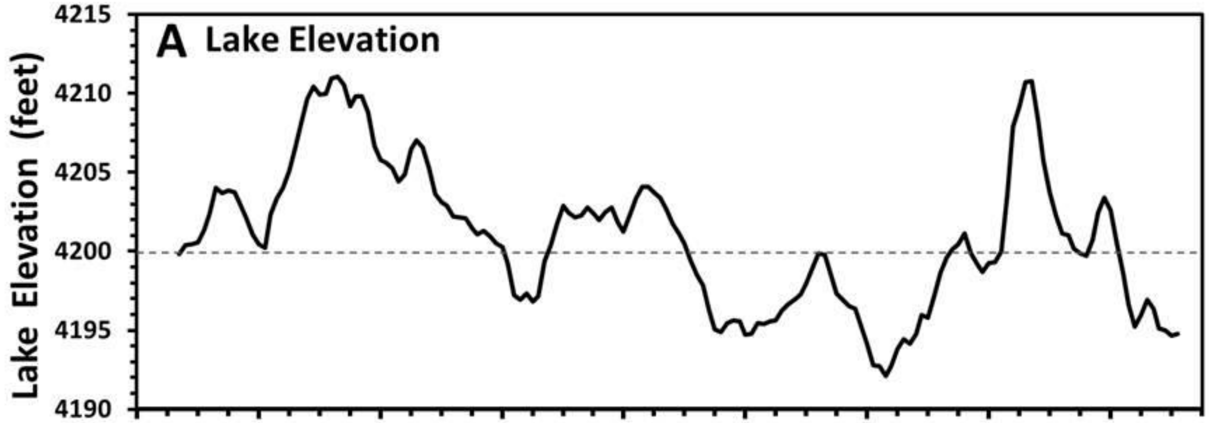
Impact of Water Diversions on Lake Levels

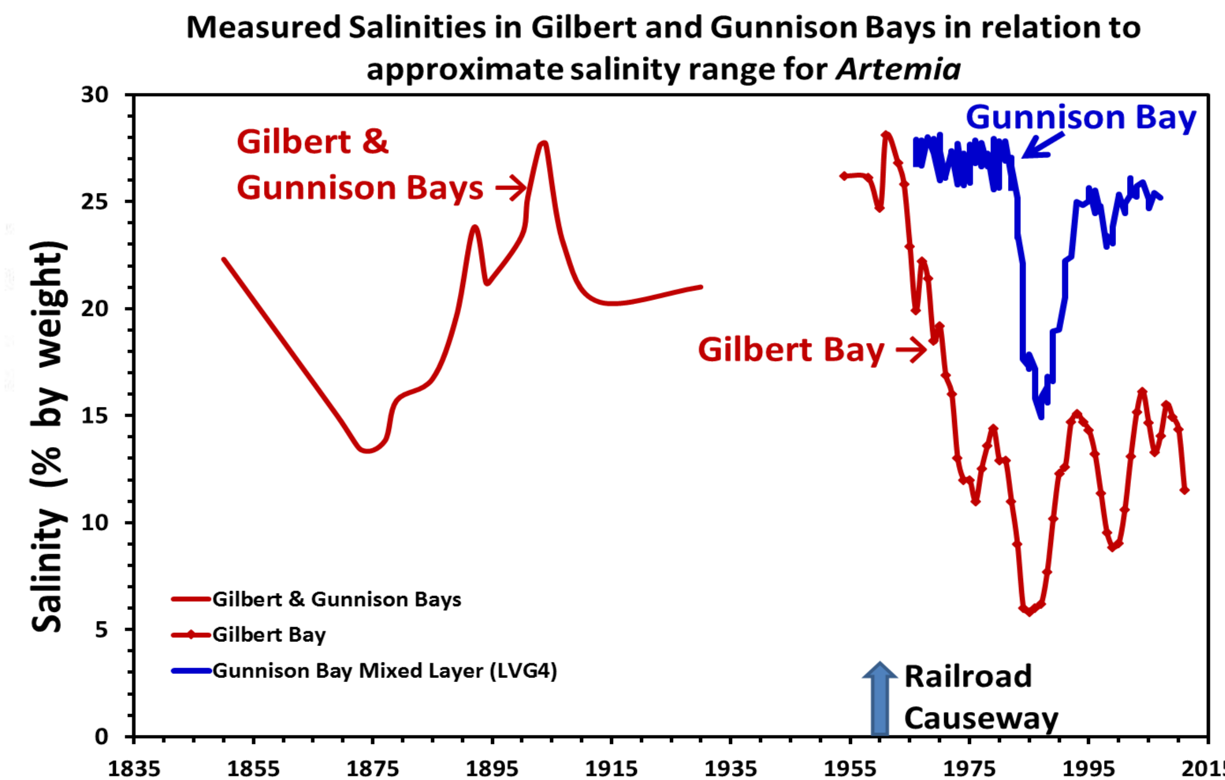


Data of Craig Miller
Utah Division of Water Resources (craigmiller@utah.gov)

*Note: Model is currently under revision and estimated natural lake levels may change

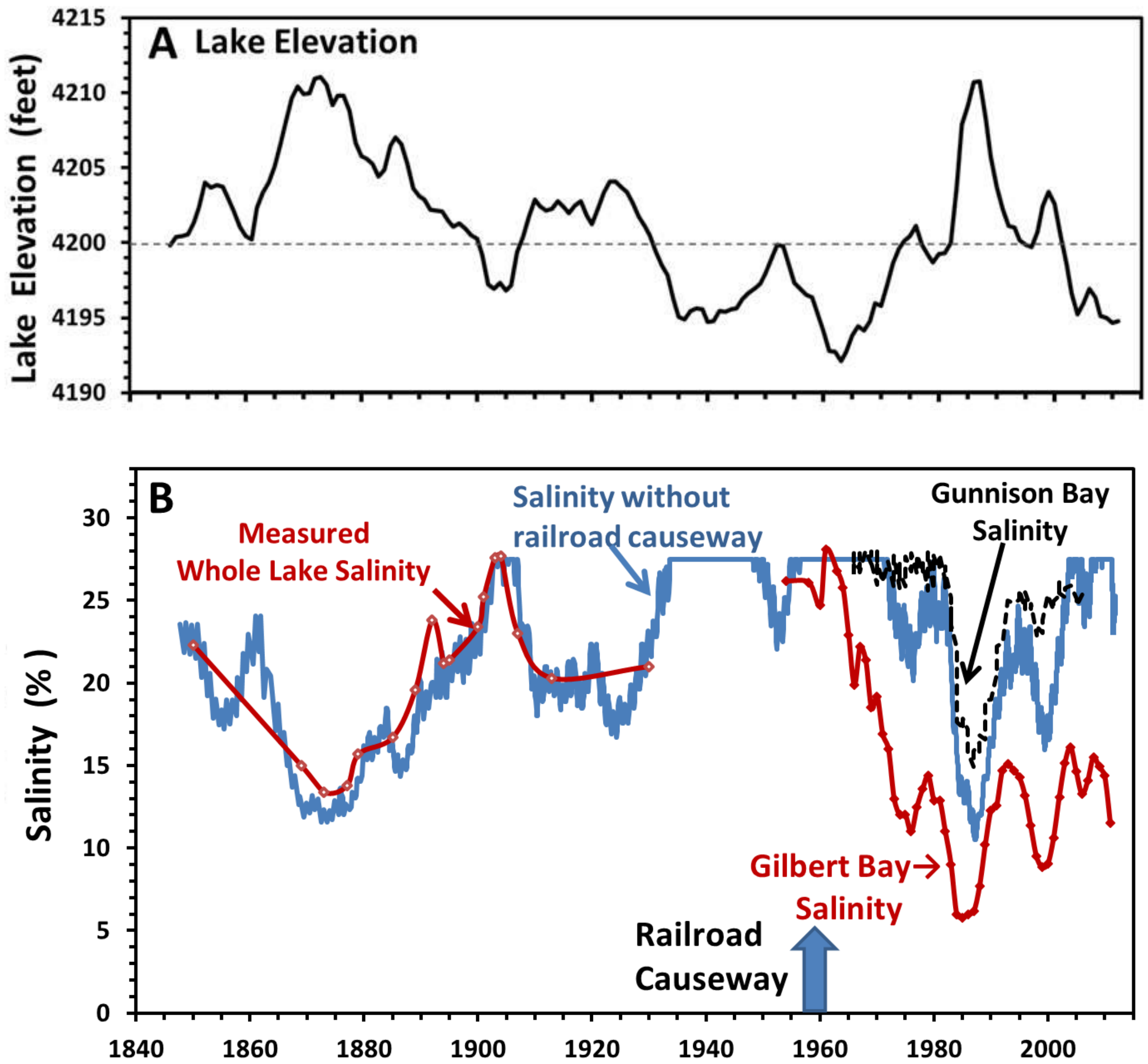
Long-term changes due to climate & causeways and diversion of fresh water





Null, S., W. Wurtsbaugh and C. Miller. 2013. Can the causeway in the Great Salt Lake be used to manage salinity? Friends of Great Salt Lake Newsletter Vol. 19 No. 1 & 2: 14-15. http://www.fogsl.org/images/stories/2013/MayNewsletterreduced.pdf

Long-term changes due to climate & causeways and diversion of fresh water



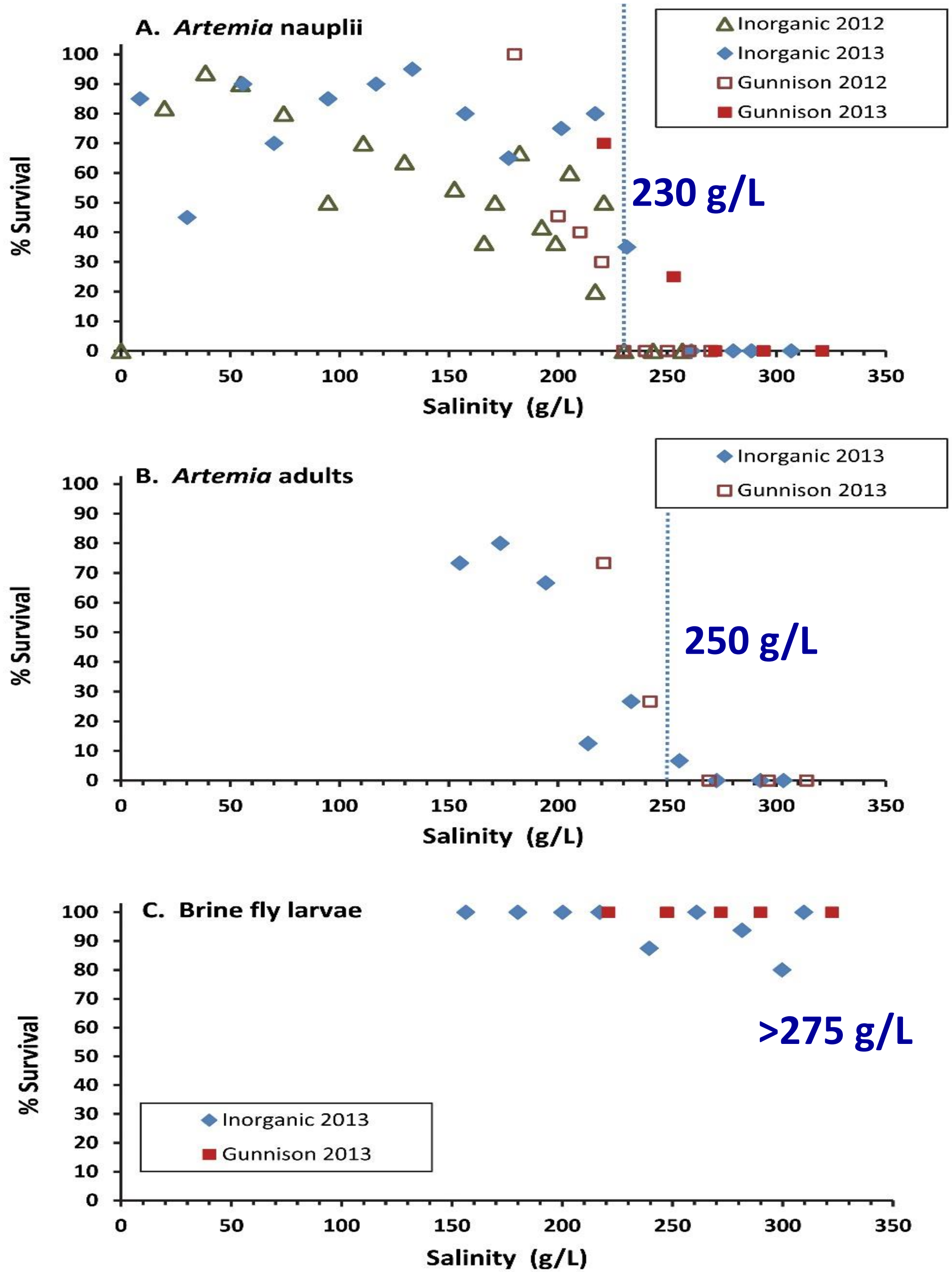
Null, S., W. Wurtsbaugh and C. Miller. 2013. Can the causeway in the Great Salt Lake be used to manage salinity? Friends of Great Salt Lake Newsletter Vol. 19 No. 1 & 2: 14-15. http://www.fogsl.org/images/stories/2013/MayNewsletterreduced.pdf

Factors changing salinities in the bays of the Great Salt Lake

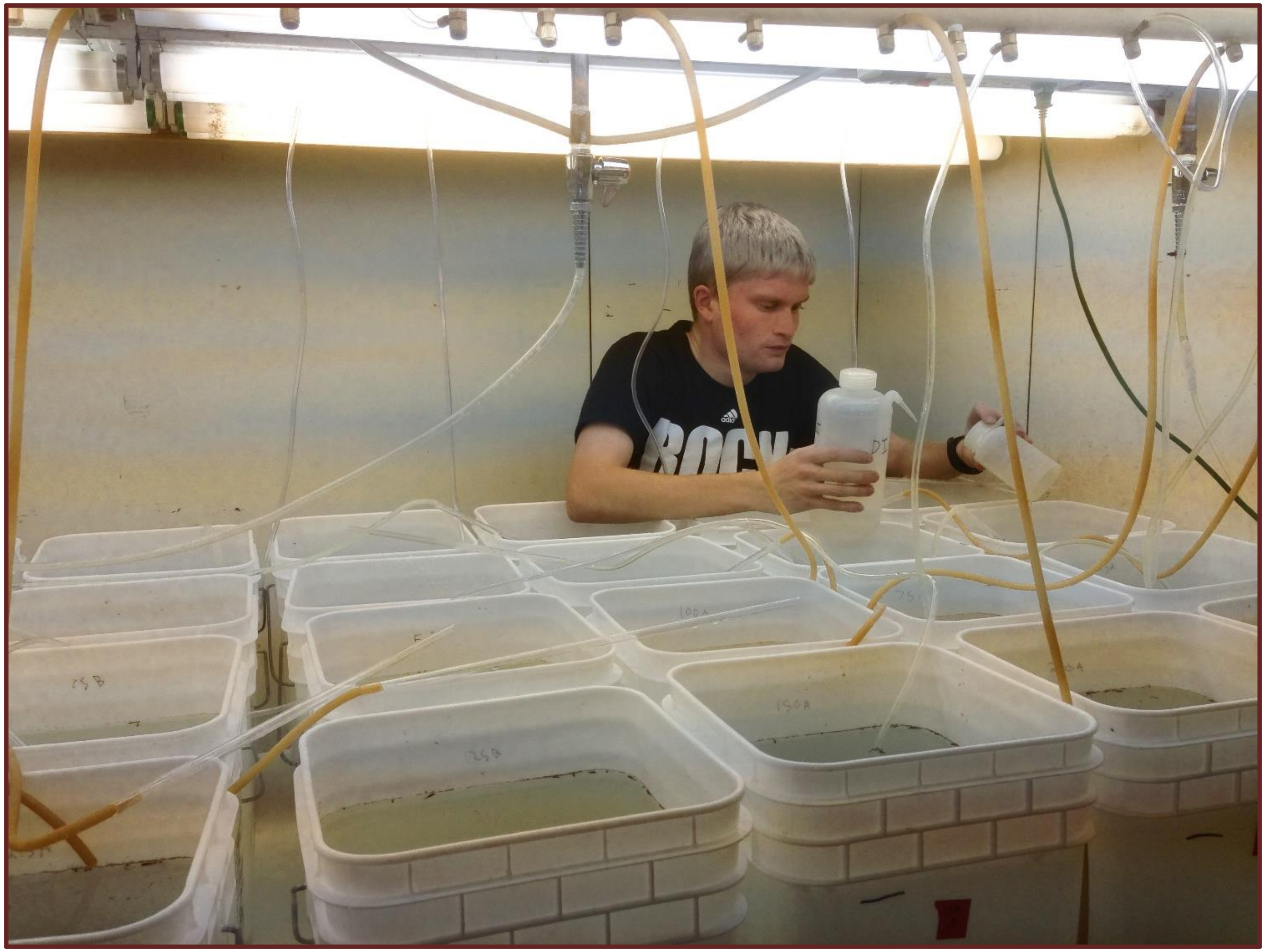
- Natural climatic variation
- Causeways cause differences between bays
- Water diversions (depletions) reduce freshwater inflow, causing salinities to rise

Experiments to test salinity requirements of Great Salt Lake organisms.

1. Short-term (48-hour) survival bioassays in flasks of different salinity



2. Microcosm test of how salinities influence the biotic communities in the Great Salt Lake



Microcosm Experiment Design

- **15-L buckets with 12 L water, 1-cm thick sediment layer**
- **25°C (summer temperatures)**
- **Light: 150 μE m^{-2} $second^{-1}$, with 18:6 light:dark cycle**
- **Physical/chemical measurements 2X/week**
- **Final organism densities measured after 30 days**

Microcosm Experiment Design

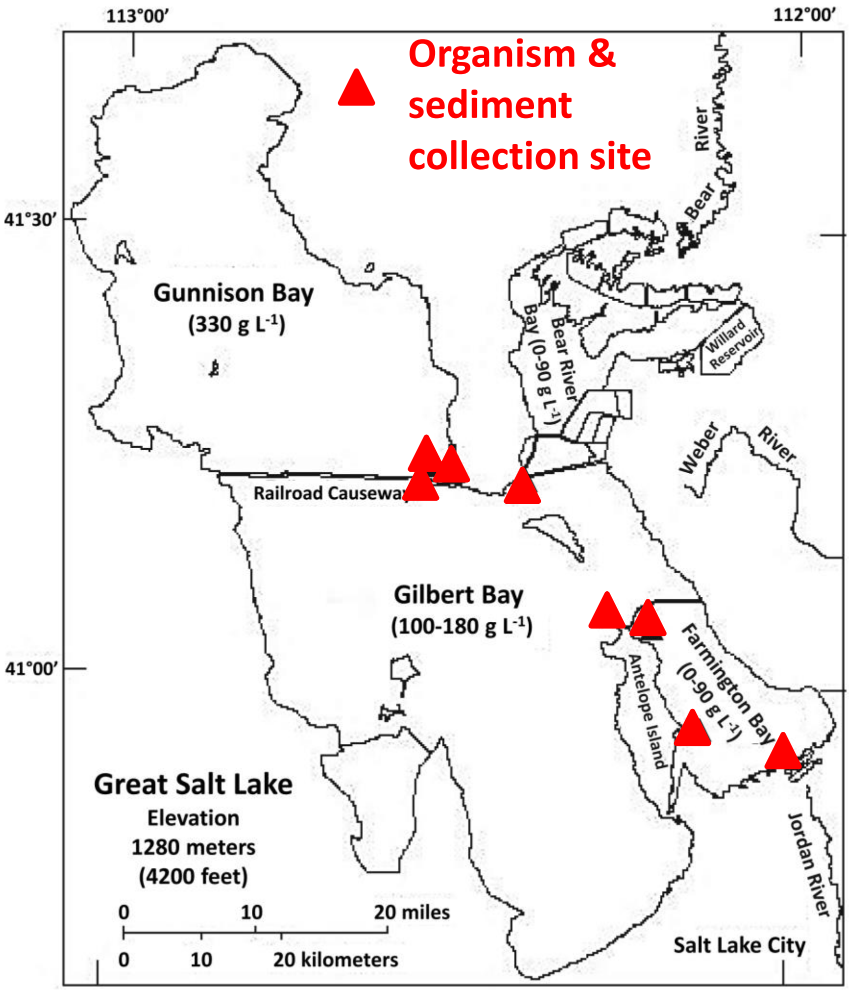
- **12 salinities**

- **2 replicate buckets/salinity treatment**

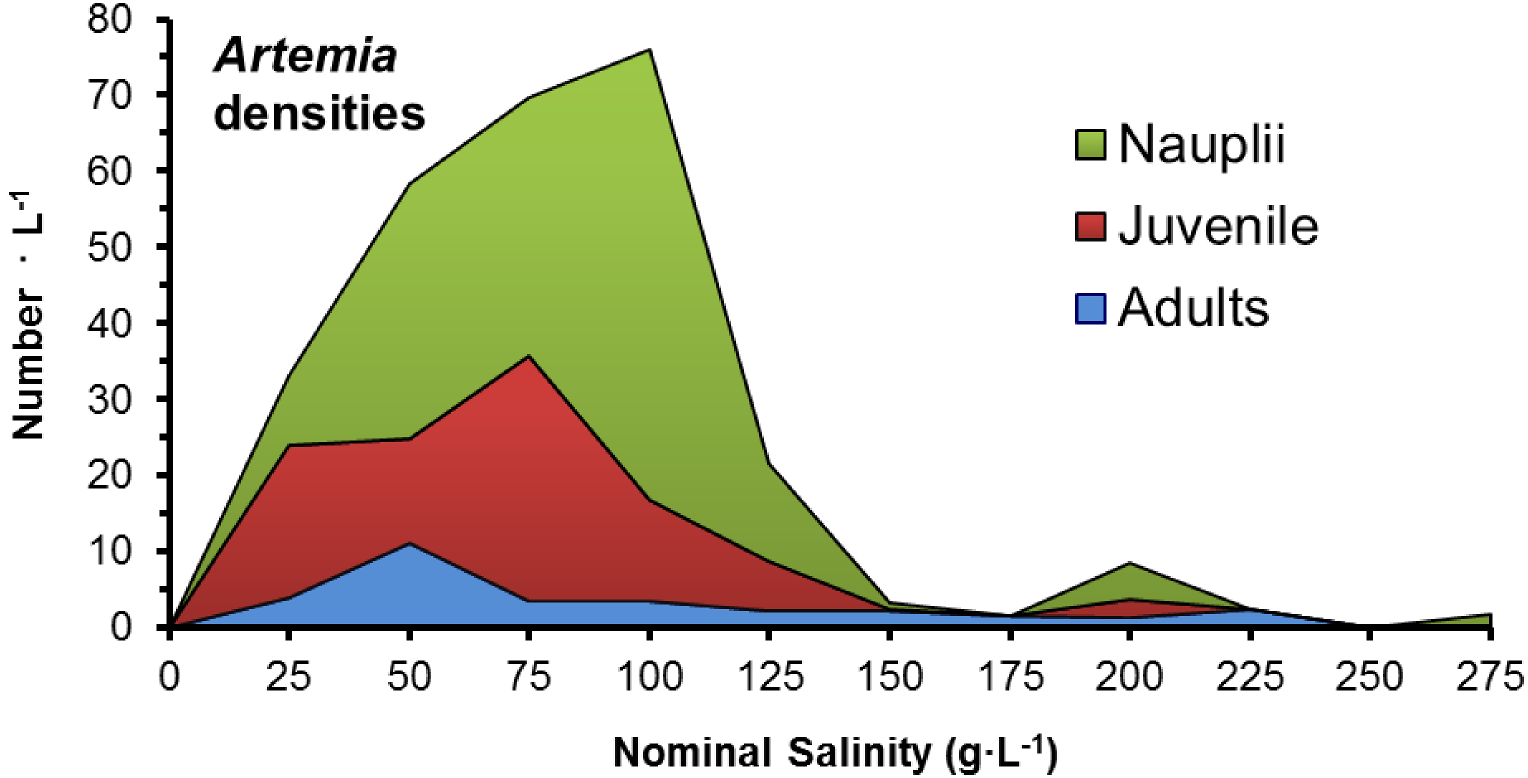
Salinities g/L	Salinities %	Simulating
10	1.0	Farmington/ Bear R. Bays
25	2.8	Farmington/ Bear R. Bays
50	5.0	Farmington/ Bear R. Bays
75	7.1	Farmington/ Bear R. Bays; Gilbert Bay
100	9.3	Gilbert Bay
125	11.7	Gilbert Bay
150	13.6	Gilbert Bay
175	15.8	Gilbert Bay
200	17.3	Gilbert Bay
225	19.4	Gilbert Bay; Gunnison Bay
250	21.4	Gunnison Bay
275	22.8	Gunnison Bay

Microcosm Experiment Design

- **Buckets seeded with organisms from a variety of salinity habitats:**
  - **Phytoplankton**
  - **Zooplankton (*Artemia*, copepods, rotifers, cladocera)**
  - **Benthic invertebrates (brine flies; gnat larvae)**
  - **Fish (mosquito fish; 2/bucket)**
  - **+ resting eggs/propagules from sediments**



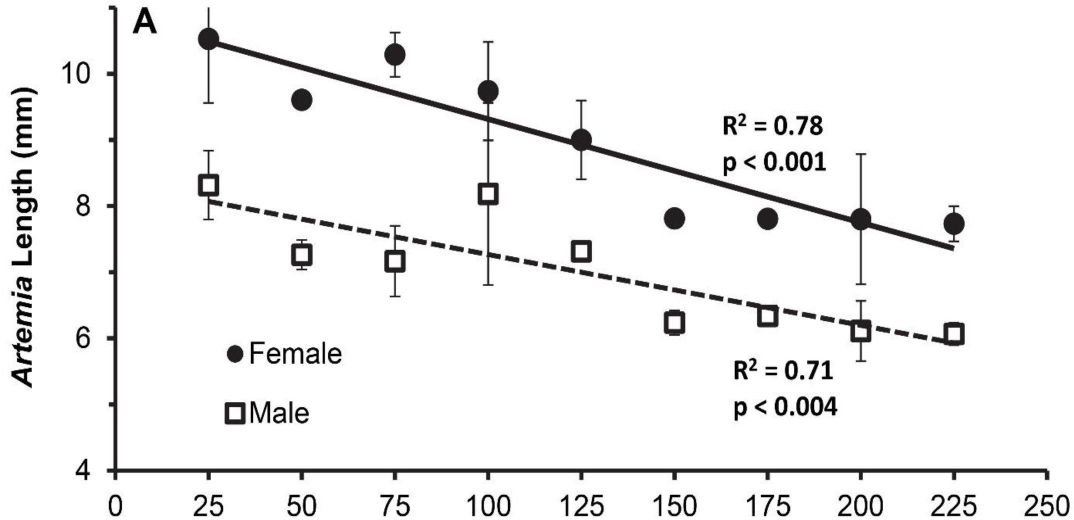
In salinities > 150 g/L brine shrimp (*Artemia*) were less abundant



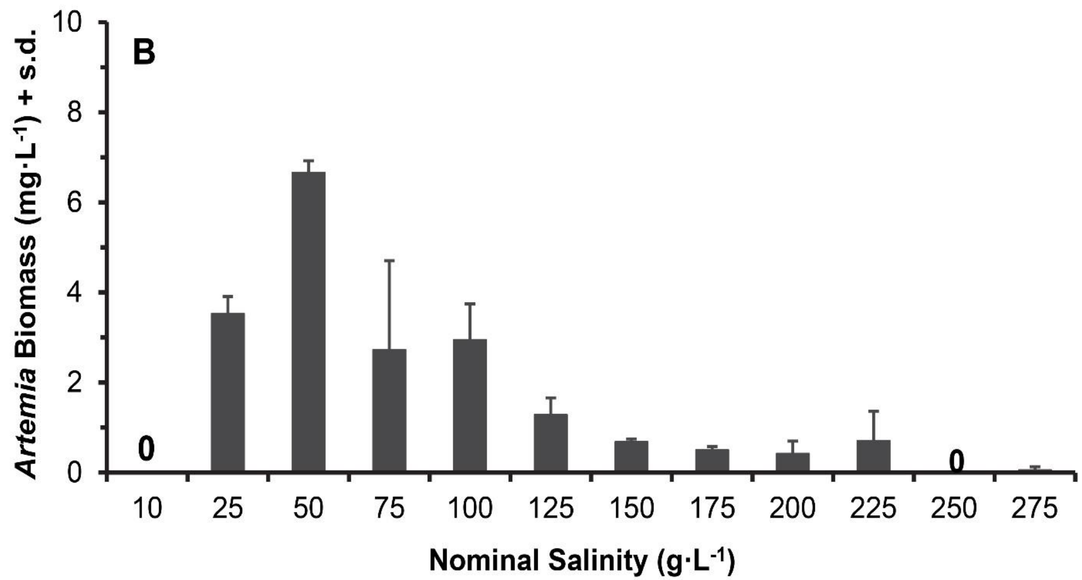
- **High densities at 25 and 50 g/Liter likely an artifact of artificially low invertebrate predator densities (not enough corixids in initial inoculum)**
- **1 adult/Liter added initially (12/bucket): these may have survived at higher salinities**

In higher salinities brine shrimp grew slowly.

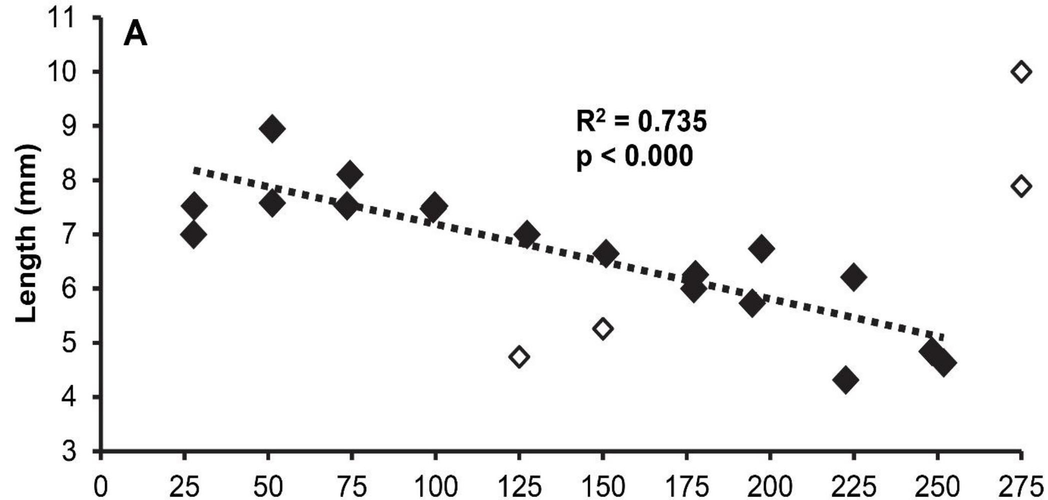
- **salinity stress**
- **low oxygen conc.**



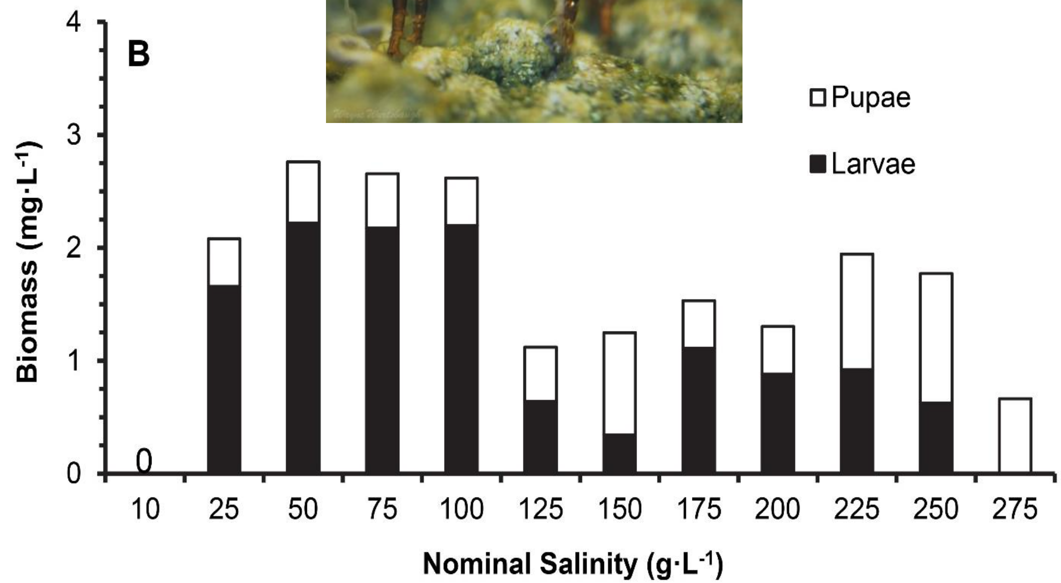
Biomass plot combines density and individual weights, and shows the same trend, with maximal biomass at 50 g/L and low biomasses above 125 g/L



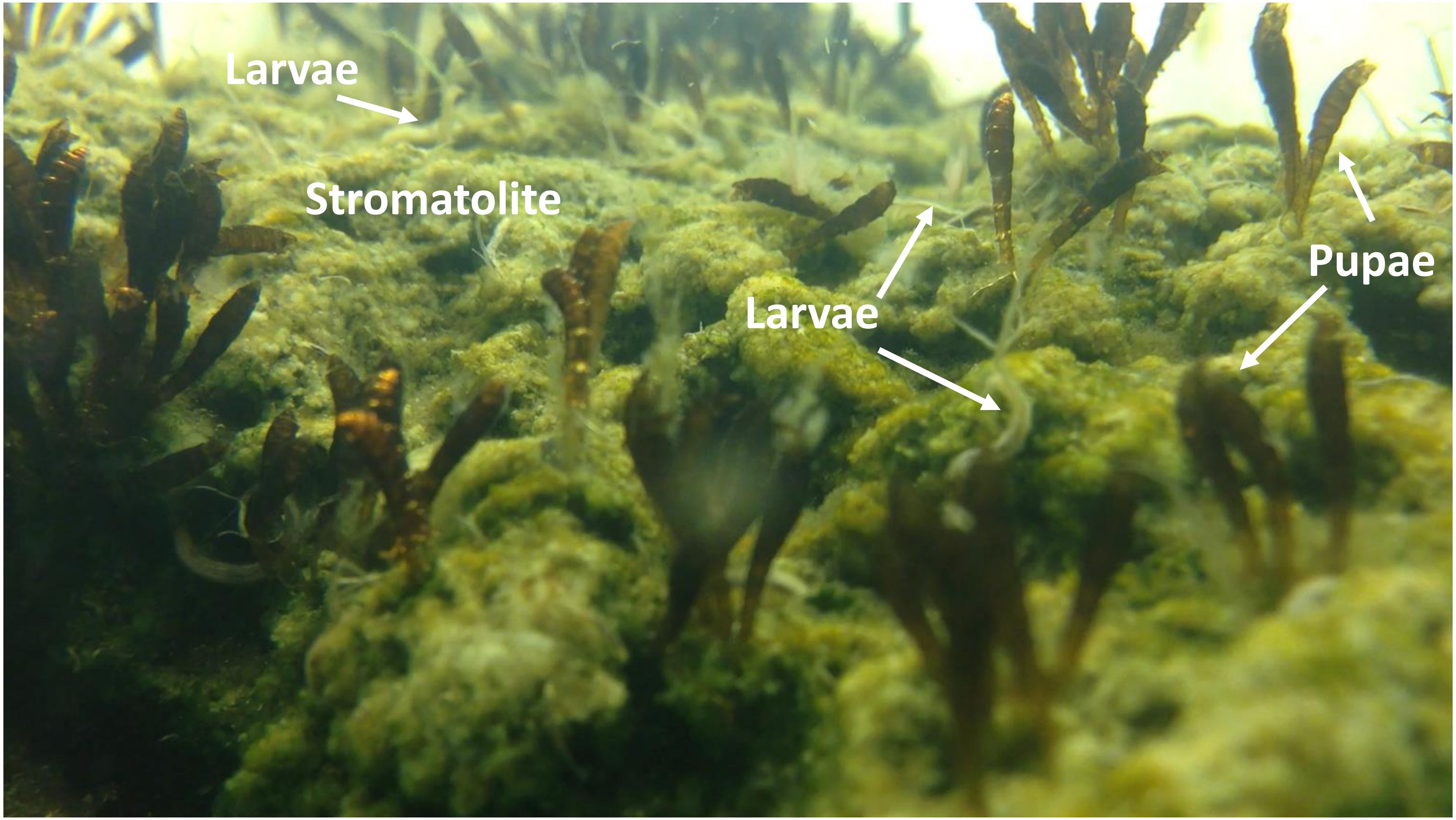
Brine fly larvae were also smaller at higher salinities



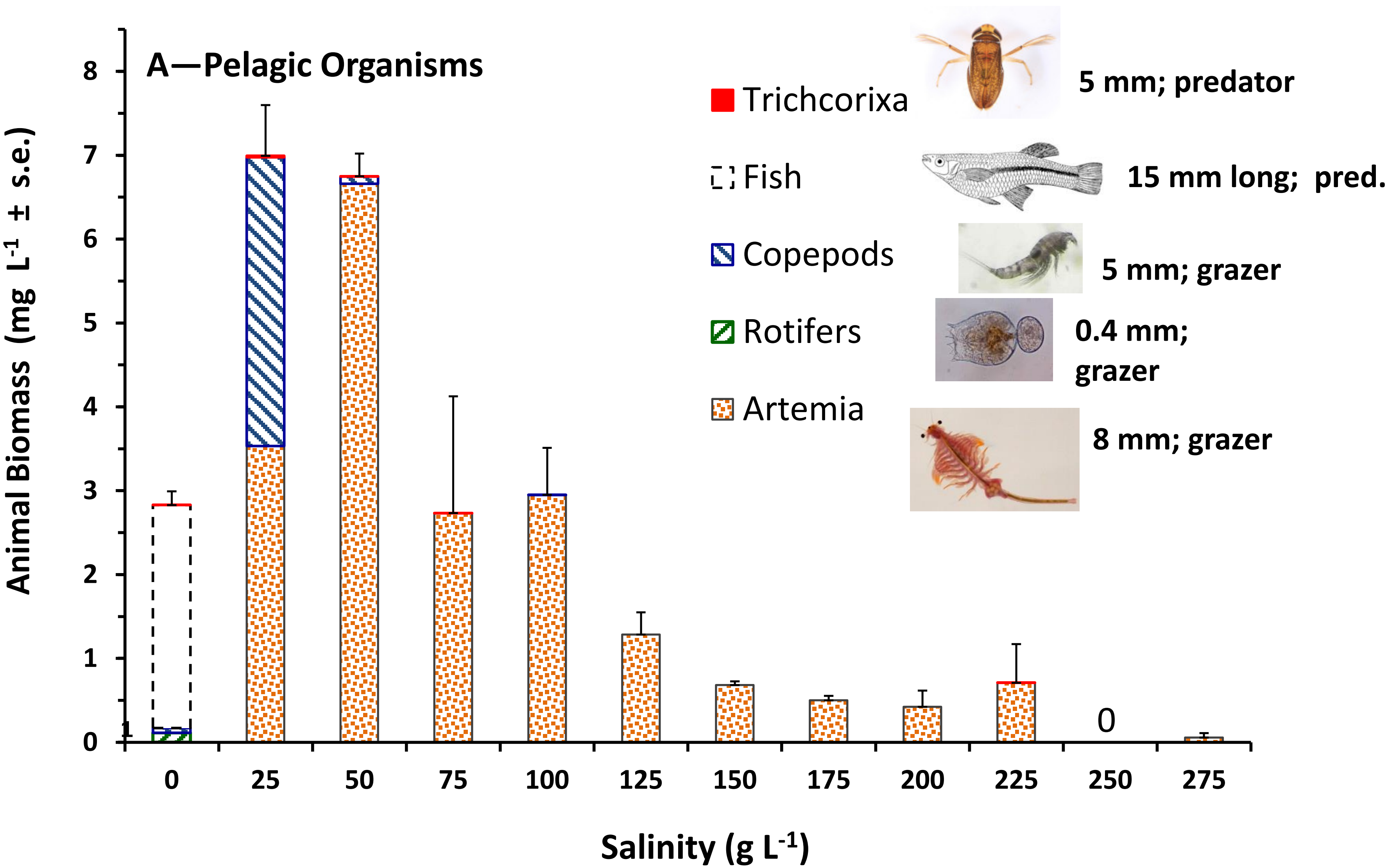
Although brine fly survival was good at all salinities except 10 g/L (fish present), the slower growth resulted in lower biomasses at high salinities. Larvae pupated earlier in the higher salinities (stress?)



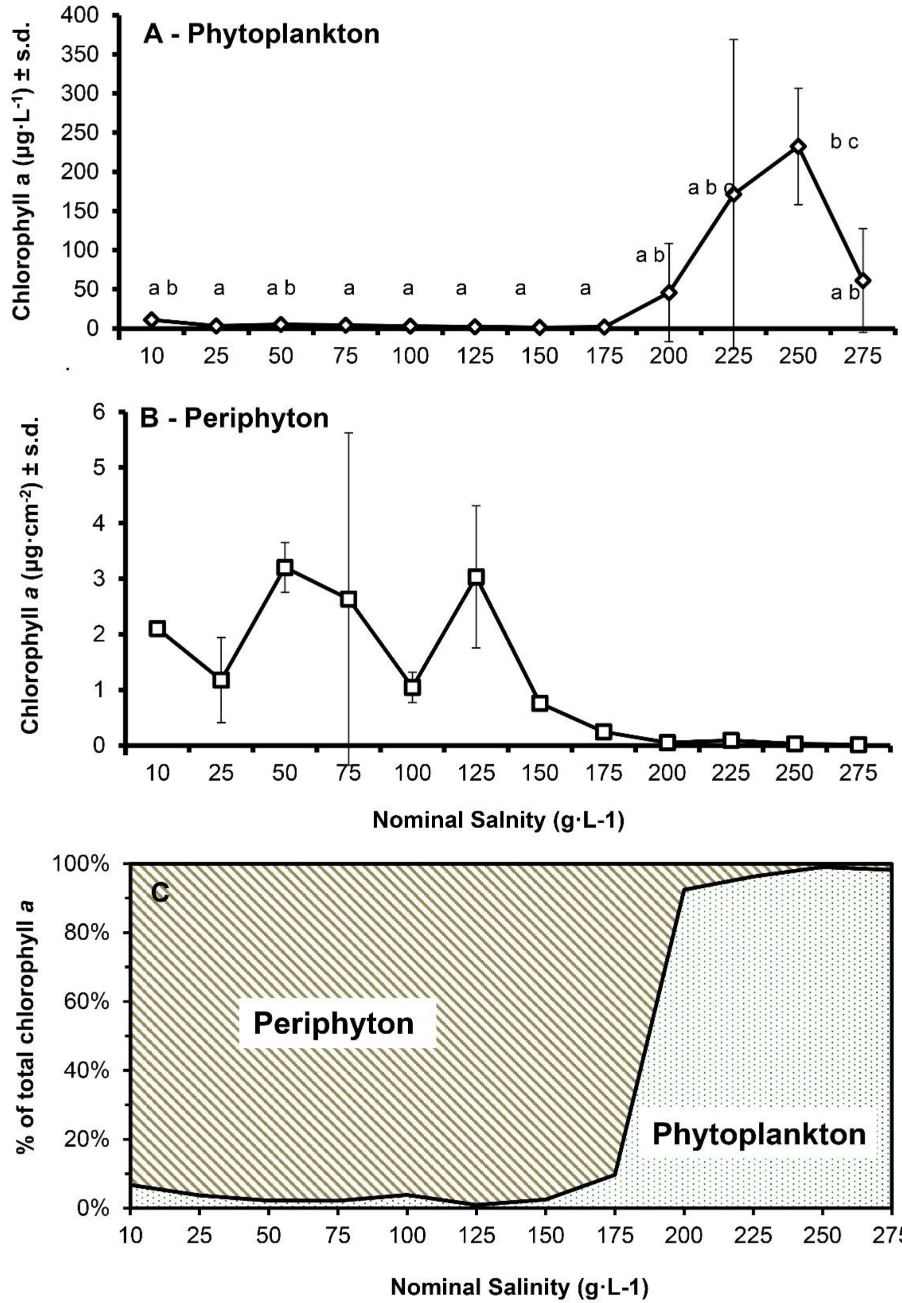
Brine fly pupae & larvae on stromatolite (biostrome) covered with w/ periphyton algae



Final biomasses of organisms in the water column

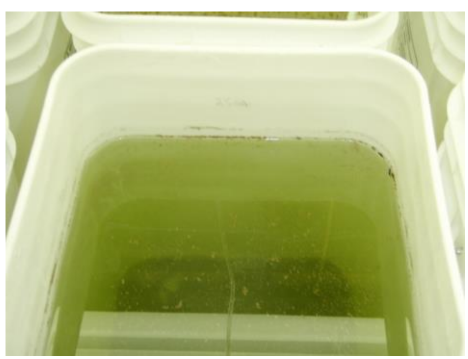


- **Phytoplankton were low when grazers (*Artemia* and others) were abundant, but increased in the high salinity treatments.**
- **Periphyton on sides of buckets was abundant when *Artemia* were present at high densities.**

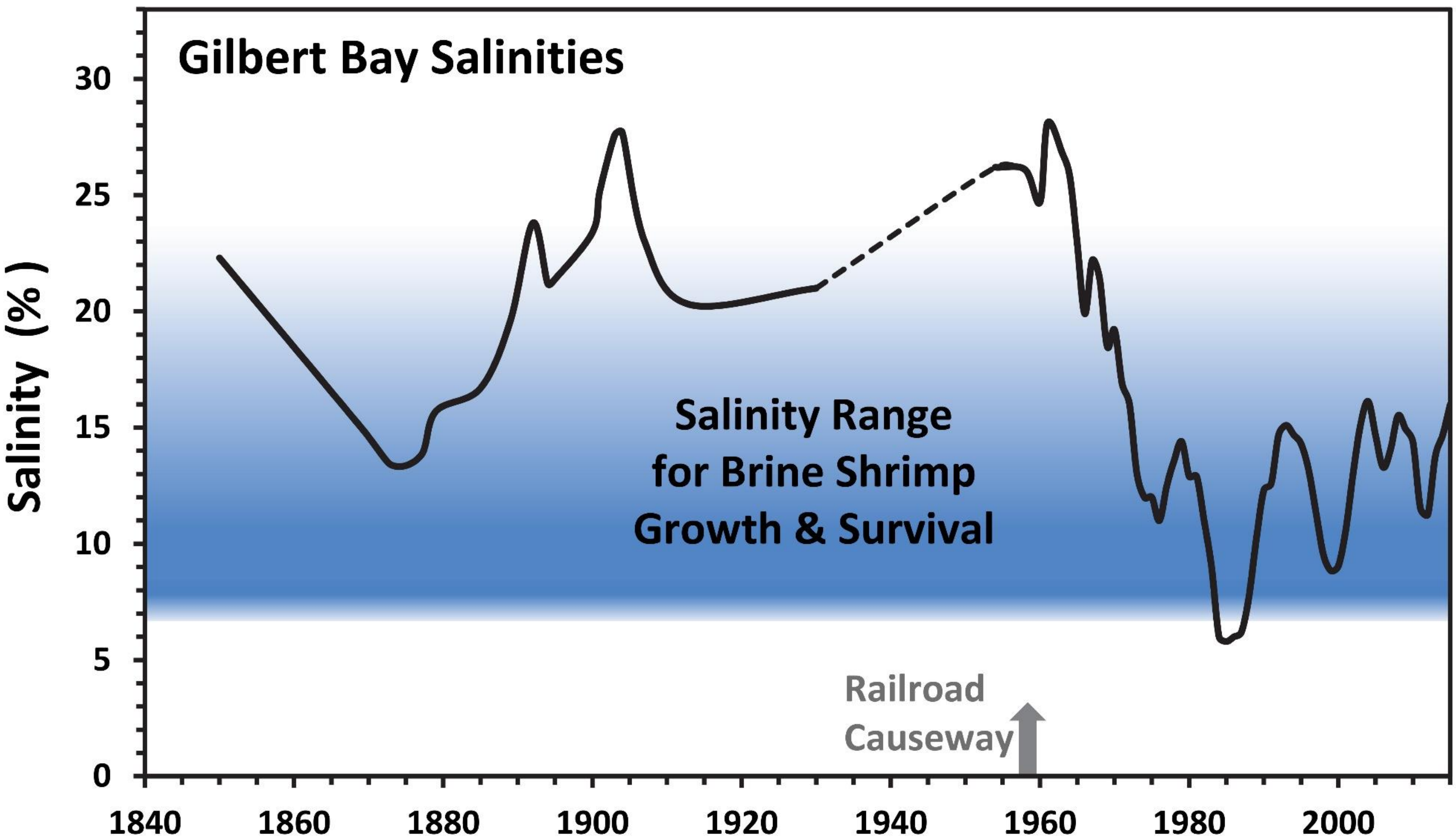


50 g/L (high periphyton)

250 g/L (high phytoplankton)



With changing lake levels, salinity will influence the species composition & production of invertebrates (and birds?) in the Great Salt Lake



Conclusions

- **The division of the lake by causeways, and the river inflows, create a diversity of salinity habitats that harbor different communities of organisms.**
- **As expected, increasing salinity decreased the numbers of taxa in the microcosms.**
- **High salinity caused slower growth rates for brine shrimp and brine flies, resulting in markedly lower biomasses at the highest salinities.**

Conclusions

- At times, the open waters of the Great Salt Lake have been too saline for significant production of brine shrimp, and perhaps brine flies.
- Depletion of freshwater inflows, and the operation of causeways have caused, and will cause, significant effects on the production of different types of invertebrates in the Great Salt Lake.

Questions?